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An analysis of first-time blood donors return behaviour using regression models

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SUMMARY

Background and Objectives: Blood products have a vital role in saving many patients' lives. The aim of this study was to analyse blood donor return behaviour.

Materials and Methods: Using a cross-sectional follow-up design of 5-year duration, 864 first-time donors who had donated blood were selected using a systematic sampling. The behaviours of donors via three response variables, return to donation, frequency of return to donation and the time interval between donations, were analysed based on logistic regression, negative binomial regression and Cox's shared frailty model for recurrent events respectively.

Results: Successful return to donation rated at 49·1% and the deferral rate was 13·3%. There was a significant reverse relationship between the frequency of return to donation and the time interval between donations. Sex, body weight and job had an effect on return to donation; weight and frequency of donation during the first year had a direct effect on the total frequency of donations. Age, weight and job had a significant effect on the time intervals between donations.

Conclusion: Aging decreases the chances of return to donation and increases the time interval between donations. Body weight affects the three response variables, i.e. the higher the weight, the more the chances of return to donation and the shorter the time interval between donations. There is a positive correlation between the frequency of donations in the first year and the total number of return to donations. Also, the shorter the time interval between donations is, the higher the frequency of donations.

Key words: first-time donor, recurrent event, regression model, return rate.

Providing healthy blood is one of the main concerns of people in charge of health in the society. This is even more important when we notice that unhealthy blood transfusion can spread some diseases, which in turn will double patients' problems (Lancet, 2005). Therefore, one of the major goals of blood transfusion centres is to find and get to know people who can donate healthy blood and to maintain them, and these donors are the real assets of blood transfusion centres. Currently, all blood donations in Iran are collected from voluntary and non-remunerated blood donors (Abolghasemi *et al.*, 2009). Blood donors constitute a small portion of people who are eligible for donation (Holdershaw *et al.*, 2003) and, according to the last estimation, there were only 25 blood donors per 1000 population in Iran (Abolghasemi *et al.*, 2009). In addition, very few donors become regular donors, whereas the need for blood and its products increases day-by-day. The outstanding questions for those in charge of blood services are why some people never volunteer to donate blood, which group(s) of people refer to these centres more often and how donors, and especially regular donors, can be educated so that the number of such donors will increase. Recognising the factors that affect blood donation will lead to better recruitment of potential regular donors. According to the standard of Iranian Blood Transfusion Organization, a regular donor donates blood at least twice a year and is thus examined regularly with given screening tests (Abolghasemi *et al.*, 2009; Gharehbaghian *et al.*, 2008). This will increase the chances of healthy blood transfusion regarding infectious diseases and will reduce the errors resulting from unhealthy blood transfusion to a minimum (Gharehbaghian *et al.*, 2008; Schreiber *et al.*, 2003). Generally speaking, the more the regular donors, the healthier the blood.

Research has shown that the time interval between two donations is an important factor in turning a first-time donor into a repeat donor (James & Matthews, 1996; Ownby *et al.*, 1999). It is clear that the shorter the interval between two donations, the more the numbers of donation. The questions are: What are the factors causing return to donation? What does the frequency of donation depend on? What affects the time intervals between two donations?

James & Matthews (1996) analysed the time interval between donations using survival regression in 1996 in Canada. Ownby *et al.* (1999) studied the statistical basis of return to donation in

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1999 in the United States using Cox model. In these research studies, the characteristics of donors such as age, gender, race and education were studied. In a study by Flegel *et al.* (2000), the donor's chance of donating in a predetermined time interval was predicted based on logistic regression model. The study showed that this chance depends on the donor's age, gender, the frequency of donation, blood type and where they live. Wu *et al.* (2001) studied the frequency of first-time donors during 6 years from 1991 to 1996 in the United States. Maghsudlu *et al.* (2009) undertook a similar study during 10 years from 1998 to 2007 in Iran. Kasraian & Tavassoli (2012) studied the relationship between first-year blood donation, return rate for subsequent donation and demographic characteristics in a 3-year period.

This study was undertaken to evaluate the factors that affect the return to donation, the frequency of donation and the time interval between donations in first-time donors based on regression models.

MATERIALS AND METHODS

The study was conducted with the approval of Research Center of Iranian Blood Transfusion Organization in one of the southwestern transfusion centres in Iran (Shahrekord Blood Transfusion Center). It was designed as a cross-sectional follow-up study for a maximum of 5 years. First, a list of donors who had donated blood for the first time from 21 March 2008 until 20 March 2009 and had been recorded in Shahrekord Blood Transfusion Center was extracted. Then, the ratio of sampling was determined, and using a systematic sampling method, the records of selected samples were taken out and the necessary information such as return to blood donation and the result of donation until 20 March 2013 were recorded. The previous information showed that about 10% of donors returned to donation for the fifth time or more, so considering a confidence of 95 and 20% of relative error, 846 people were sampled. Based on the volunteers' records, demographic data including age at the time of the first donation, gender, body weight, marital status, education, place of living, job and also blood related factors such as blood type and blood Rh were collected.

STATISTICAL ANALYSIS

To recognise the factors affecting return to donation, the logistic regression model was applied. In this model, the response variable for a person who did not return to donation was taken as 0 and it was taken as 1 for the one who returned to donation at least once. The frequency of return to donation was a count variable with over-dispersion, so the analysis of this variable was done using count regression of negative binomial (Agresti, 2007). Considering the survival analysis framework, donation was taken as 'failure event' and the 'survival time' was defined as the time interval between donations. If the donor returned to donation and donated successfully, the censor indicator was taken as 1 for him/her and it was taken as 0 if he/she did not return to donation or could not donate successfully. Also, the time interval between the last donation and the end of the study was considered as censored survival data. The time intervals between donations are a multivariate survival data, known as recurrent events data (Hougaard, 2000). As recurrent survival times are dependent on each other, Cox's shared frailty model was used to determine this dependency and to remove its effect on the estimate of regression parameters. In this model, the times between blood donations were entered into the model simultaneously (Kleinbaum & Klein, 2012). Data analysis was performed using the statistical software R version 3·0.1 (R Project, 2013).

RESULTS

Of the 864 samples, 801 people (92·7%) were male and 63 were female. The donors' age at the first donation was from 21 to 75 with mean of $36{\cdot}6 \pm 10{\cdot}7$ years; 31·8% of them were aged 21–29 years, 32·2% were aged 30–39 years, 22·2% were aged 40–49 years, 1–0·5% were aged 50 to 59 years and 3·2% were aged 60 years or above. Their body weight at the first donation was from 45 to 130 kg with the mean of $77{\cdot}8 \pm 11{\cdot}7$ kg. Also 623 people (72·1%) were married at their first donation and the remainder (241) were single; 710 of them (82·2%) lived in the city and 154 in the country.

The frequency of donation during 5 years was from 1 to 13 with the mean of $2{\cdot}41 \pm 2{\cdot}16$ and the sum of 2081 times. Of 864 samples, 424 people (49·1%) had at least one other successful donation while 440 people either never returned to donation or were deferred for some reason, when they did. The frequency of successful return to donation with respect to marital status, stay, education level, job class, blood type and donor's Rh is shown in Table 1. The ratio of return to donation in men was higher than women: men's return to donation was 50·4% while it was 31·7% for women. Odds ratio of return to donation for men compared with women was 2·19 with the 95% confidence interval of 1·27–3·79.

Totally, 86·7% of returns to donation were successful, while 13·3% could not donate successfully for some reason. The numbers of successful return(s) were from 0 to 12 times with the mean of $1{\cdot}41 \pm 2{\cdot}16$. For those who returned to donate, the mean interval between the first and the second donations was 554 ± 404 days, between the second and the third donations was 383 ± 298 days and between the third and the fourth donations was 310 ± 298 days. Spearman correlation co-efficient showed a reverse significant relation between the frequency of donation and the time interval between them: the shorter the time interval between donations, the higher the frequency of donations. This co-efficient for people who returned to donation for the first-time interval with the frequency of donation was equal to $-0{\cdot}43$.

The results of the logistic regression model are shown in Table 2. According to this model, body weight and the job class had a significant effect on return to donation. Odds ratio for body weight was equal to 1·035, i.e. with increasing 1 kg of body weight, the ratio of chances for returning to not returning to

Table 1. Frequency of donation based on demographic characteristics during the study

		Return to donate			
		Yes		No	
Variable	Level	Number	Percent	Number	Percent
Marital status	Married	317	50·9	306	49·1
	Single	123	51·0	118	49·0
Stay	Urban	366	51·5	344	48·5
	Rural	74	48·1	80	51·9
	Elementary	89	56·3	69	43·7
Education	High School	105	50·7	102	49·3
	Diploma	160	52·5	145	47·5
	University	86	44·3	108	55·7
	Housekeeper	38	74·5	13	25·5
	Clerical	67	39·9	101	60·1
Job	Worker	71	54·6	59	45·4
	Free Job	194	50·3	192	49·7
	Student	70	54·3	59	45·7
	AB	32	55·2	26	44·8
Blood type	B	83	52·2	76	47·8
	A	150	53·0	133	47·0
	O	175	48·1	189	51·9
Rh	Positive	403	50·8	390	49·2
	Negative	37	52·1	34	47·9
Total		440	50·9	424	49·1

donation increases by 3·5%. Furthermore, the highest percentage of return to donation belonged to clerical jobs and the lowest to housekeepers.

The results of the negative binomial regression model for the factors affecting frequency of return to donation are shown in Table 3. The frequency of return to donation during the first year has a positive significant effect on the total number of donations: the more the numbers of donation during the first year, the higher the total number of donations. Moreover, body weight has a positive effect: the frequency of return to donation was higher for people with higher body weights.

The results of Cox's shared frailty model for recurrent events in order to simultaneously analyse the 11 time intervals between returns to donation are shown in Table 4. It can be seen that age, body weight and job class at the time of the first donation have a significant effect on time intervals between donations. Age has a negative effect on time intervals between donations: the younger the donor, the higher the chances of further donations, i.e. the time interval between two donations has been shorter. Job classes of clerks, workers, the self-employed and university students have had a higher chance of donation compared with housekeepers, i.e. they have returned to donation sooner than housekeepers. Results also show that time intervals between the 2nd and 10th donations are different from that of the first-time interval (i.e. the time interval between the first and the second donation). The 11th interval does not differ from that of the 1st one. The frailty effect is significant, which in turn indicates a correlation between interval times of each donor.

DISCUSSION

Identifying the statistical behaviour of first-time donors is important in attracting people to donate regularly. Maintaining these donors and encouraging them to return to donation will help significantly with achieving adequate and healthy blood stocks.

In this study, return to blood donation was obtained at 49·1% and deferral donation was obtained at 13·3%. This finding is consistent with other Iranian studies, which shows that repeated donors ranged from 40 to 50% and deferred donors ranged from 13 to 19% (Gharehbaghian *et al.*, 2008; Abolghasemi *et al.*, 2009; Kasraian & Tavassoli, 2012). It seems that, in Iran, the rate of repeated donors is very low and the rate of deferred donors is very high compared with developed countries (Mahmoodian-Shooshtari & Pourfathollah, 2006).

The frequency of donation during 5 years has had a positive correlation with the frequency of donation during the first year, i.e. the higher the frequency of donation during the first year, the higher the total frequency of donation during five years. A similar relationship was observed in two other studies, one done by Schreiber *et al.* (2005) and the other by Kasraian & Tavassoli, (2012).

In this study, as the number of donations increased, the mean interval between donations decreased. Also, a significant reverse relation between the frequency of donations and the time intervals between donations was seen: the shorter the time interval between two donations, the more frequent the donations.

Table 2. Results of the logistic regression model for dependent variable of return to donation

Variables	Co-efficient	Standard error	Significance	Odds ratio	95% CI for OR	
					Lower	Upper
Body weight (kg)	0·034	0·006	<0·001	1·035	1·022	1·048
Job			0·014			
Clerical vs housekeeper	1·363	0·363	<0·001	3·909	1·917	7·969
Worker vs housekeeper	0·748	0·372	0·045	2·113	1·018	4·384
Free job vs housekeeper	1·000	0·342	0·003	2·718	1·390	5·314
Student vs housekeeper	0·971	0·373	0·009	2·640	1·272	5·480
Intercept	−3·690	0·587	<0·001			

Table 3. Results of negative binomial regression model for dependent variable of number of return to blood donation

Variables	Co-efficient	SE of co-efficient	Significance
Number of first-year donations	2·285	0·106	<0·0001
Body weight (kg)	0·030	0·005	<0·0001
Job			
Clerical vs housekeeper	0·527	0·273	0·053
Worker vs housekeeper	0·307	0·282	0·276
Free job vs housekeeper	0·471	0·253	0·064
Student vs housekeeper	0·616	0·282	0·029

Table 4. Results of the Cox's shared frailty models for analysing time between donations

Variables	Co-efficient	SE of co-efficient	Significance
Donor duration			
Second vs first	0·396	0·088	<0·0001
Third vs first	0·326	0·103	0·0015
Fourth vs first	0·483	0·122	0·0002
Fifth vs first	0·689	0·143	<0·0001
Sixth vs first	0·737	0·165	<0·0001
Seventh vs first	1·156	0·188	<0·0001
Eight vs first	0·781	0·223	0·0005
Ninth vs first	0·857	0·256	0·001
Tenth vs first	0·714	0·303	0·018
Eleventh vs first	−0·314	0·521	0·55
Age	−0·01	0·005	0·027
Body weight	0·023	0·004	<0·0001
Job			
Clerical vs housekeeper	0·758	0·257	0·0033
Worker vs housekeeper	0·623	0·264	0·019
Free job vs housekeeper	0·595	0·249	0·017
Student vs housekeeper	0·895	0·269	0·0009
Random effect	–	–	<0·0001

This correlation has had an impact especially on the first-time interval. Two studies showed a short-time interval between the first and second donations and increased the chances of repeated donations (James & Matthews, 1996; Ownby *et al.*, 1999). The result of survival model showed that there is a positive correlation between time intervals for each donor; in other words, a donor has returned for donation either in long-term or short-term intervals, which shows the donor's behaviour regarding return to donation.

In the present study only 7·3% of donors were females. This percentage is a good estimate of female donors in this area, given the fact that a systematic sampling of first-time donors during 1 year was done, which in turn indicates the low contribution of women to blood donation in this region of Iran. Return to donation among women rated at 31·7%, while it was 50·4% for men, which shows a significant difference. Totally, by including women's share in donation and the rate of return to donation among them, if a returned donor is chosen randomly, there is only 2% chance that the selected donor would be a woman. The rate of contribution to donation by women was only 8% across the country in 2007 (Maghsudlu *et al.*, 2009), which is very low compared with that of developed countries (James & Matthews, 1996; Flegel *et al.*, 2000; Wu *et al.*, 2001; Germain *et al.*, 2007; Marantidou *et al.*, 2007). Studies in some other parts of Iran (Kasraian & Tavassoli, 2012; Javadzadeh Shahshahani, 2007) and also a study in Turkey (Ersan *et al.*, 2012) show the low contribution of women to donation. Some reasons for this low contribution in Iran were preception of becoming anaemic, fear of needle, concern for catching infectious diseases, lack of time, difficulty in accessing the donation sites, unawareness of the importance of blood donation and lack of permission by husband (Javadzadeh Shahshahani, 2007; Maghsudlu *et al.*, 2009). It seems that in the Islamic countries such as Iran, increasing the women's knowledge, reassuring them about their fears and doubts, advertisement in media, providing a suitable donation site and increasing the knowledge of their husbands will increase their donation contribution. However, further research should be done to recognise and deal with the reasons why Iranian women are not donating blood.

This study shows that age has an effect on the time intervals between donations, i.e. as the age increased, the chances of return to donation decreased, and accordingly the time interval until the next donation increased. The present study shows that the rate of return to donation among donors of clerical job class

has been the highest, 60·1%, and for donors of housekeeper job class it has been the lowest, 25·5%. Furthermore, the job class has been effective on return to donation at the presence of other variables. On the other hand, the job class has affected the time intervals between two donations. In spite of the fact that job class alone has affected the frequency of blood donation, it has had no effect on the frequency of return to donations at the presence of other variables.

This study represented that body weight has a big effect on donation behaviour of donors, so that body weight has affected all three response variables of return to donation, frequency of return to donation and time intervals between donations. The findings suggest that high body weight increases the chances of return to donation and its frequency; it also decreases the time intervals between donations. However, the fact that people with moderate body weights have not referred to transfusion centres to donate should be dealt with. Why have they referred less frequently than those with higher body weights? Even though many studies have been undertaken regarding the donors' behaviours and the factors affecting such behaviours, in none of them the important effect of body weight has been studied.

The highest rate of return to donation belonged to people with university education at 55·7% and the lowest to people with primary school education at 43·7%; there was no correlation between education level and return to donation. Nevertheless, it should be taken into consideration that the educational level of the donors had a significant correlation with their job classes, so it can be said that there has been a positive, yet indirect, correlation between education and return to donation. In addition, education did not show any significant correlation with the frequency of donation and time intervals between donations.

The present study did not show a significant difference between donors from the city and donors from the country's return behaviour; since the blood transfusion centre in this study was located in the city, it was noted that living close to or far from the transfusion centre has no effect on return to donation. Also, the findings did not show any direct relation between marital status and the response of return to donation, yet in view of the fact that marital status has a positive correlation with age and body weight, it can be said that being/getting married increases the chances of return to donation indirectly. Blood type has not had any impact on any of the response variables. Even if the psychological factor is considered effective on the more frequent return of blood type O, and less frequent return of blood type AB, it has not had a big impact in this study. Regarding Rh, 91·8% of donors have had a positive Rh. Return to donation for people with a positive Rh has been 49·2% and for people with a negative Rh has been 47·9%, which means that like blood type, Rh has not had a significant impact on any of the three response variables.

One of the limitations of this research has been the fact that, if a donor refers to any other transfusion centre other than Shahrekord and its branches, his/her data could not have been included in this research. So it is expected that the rate of return to donation might be underestimated.

CONCLUSION

In general, the findings of this study show that sex, age, body weight, job class of the first-time donors and the frequency of donation during the first year play an important role in their return donation behaviour; therefore, some strategies and programs should be applied to encourage the first-time donors to donate more often during the first year of donation, so that the chance of becoming a regular donor will increase. Also, an educational programme should be planned, on a national and regional scale, especially for the low donation groups such as women, people with moderate body weight and higher age groups, in order to motivate and encourage them to donate more frequently.

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CONFLICT OF INTEREST

The authors have no competing interests.

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